PATENT SPECIFICATION (11) 1 266 132

1266 132

DRAWINGS ATTACHED

(21) Application No. 56308/67 (22) Filed 12 Dec. 1967

(23) Complete Specification filed 12 March 1969

(45) Complete Specification published 8 March 1972

(51) International Classification B 23 q 5/22

(52) Index at acceptance
B3C 1A16A 1A4C 7B15 1B21 1B7F 1B8A 1B8B 1B8H 1D F2Q 6A 6G

(72) Inventor ALAN PHILIP LAWLESS THOMAS

(54) IMPROVEMENTS IN, OR RELATING TO, SELF-CONTAINED MACHINING HEADS

(71) I, ALAN PHILIP LAWLESS THOMAS, a British Subject, of Marston Hall, Marston Green, Warwickshire, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to self-contained machining heads for drilling, reaming, counterboring, spot-facing or performing analogous operations on workpieces, each of the heads being of the kind (hereinafter called the kind referred to) wherein by a threaded, motor-driven spindle engages in and is rotatable in the same direction as, a motor-driven lead nut so that, by varying the relative speeds at which the spindle and nut are rotated during each cycle of operations of the head, the spindle may be fed axially forwards from a base position at a relatively rapid speed to advance tooling which can be carried thereon towards a workpiece, the forwards feed may be continued at a slower speed whilst the tooling operates on the workpiece and, upon completion of the operations, the spindle may be returned to the base position at a relatively rapid speed to retract the tooling from the workpiece.

The objects of the invention are to provide an improved machining head which comprises a minimum number of component parts so that it is of simple and economical construction, and to enable the speed at which the spindle is fed forwards whilst the tooling is operating on a workpiece, to be adjusted in a gradual or stepless manner.

In accordance with the present invention a self-contained machining head of the kind referred to, comprises two electric motors, of which at least one surrounds and is co-axial to the spindle, for respectively driving the spindle and lead nut, a master switch for connecting a first one of the motors to a supply of current to initiate an operational cycle of the head, a change over switch operable in response to a change in the axial position of the spindle as the spindle is advanced towards a workpiece, for connecting the second one of the motors to the current supply and at least one of the motors to the supply through manually adjustable thyristors or equivalent electronic devices, and a forward limit switch operable in response to a change in the axial position of the spindle as the tooling operates on the workpiece, for disconnecting the said first motor and the electronic devices from the supply.

Preferably the head also comprises a rear limit switch which is operable in response to a change in the axial position of the spindle as the tooling is retracted from the workpiece, for disconnecting the second motor from the supply, and a clutch of which the co-operating drive-transmitting members are, respectively, fast when the spindle and lead nut are engageable to enable the spindle and nut to be rotated at the same speed, also as the tooling is retracted from the workpiece, the location of the rear limit switch axially of the spindle is adjustable so that, as desired, either the switch may be operated or the clutch may be engaged as the tooling is retracted, and the master switch is adapted to disconnect the second motor from the supply when actuated to connect the first motor to the supply if such disconnection has not been effected previously by the rear limit switch.

Desirably the two motors are of the alternating current type and the forward limit switch is adapted, when operated to disconnect the said first motor from a supply of alternating current, to effect the connection of the motor to a supply of direct current so that rotation of the motor rotor is terminated instantaneously.

In order that the invention may be understood and carried into practice more readily, reference will now be made to the accompanying drawings wherein: —

Figure 1 is a sectional elevation of a self-

contained machining head wherein the two motors are arranged in co-axial alignment.

Figure 2 is a sectional elevation of a self-contained machining head wherein the two motors are arranged side-by-side;

Figure 3 is an end elevation, partly in section along the line *a—a*, Figure 2;

Figure 4 is a schematic plan of a constructional detail;

Figure 5 is a wiring diagram of the motor control circuit, and

Figure 6 is a wiring diagram of the motor power circuit.

The body of the machining head shown in Figure 1, comprises a rear end member 1, an intermediate member 2 and a front end member 3 which are recessed and secured together, by ties, bolts or analogous expedients (not shown) so as to clamp the stator 4 of a main, alternating current electric motor *M* between the members 1 and 2, and the stator 5 of a feed, alternating current electric motor *F* between the members 2 and 3 with the said stators in co-axial alignment.

The rotor 6 of the main motor encircles and is fast upon a sleeve 7 which is supported by and is rotatable in bearings 8 and 9 provided, respectively, in the body members 1 and 2, and the rotor 10 of the feed motor encircles and is fast upon a lead nut 11 which, in like manner, is supported by and is rotatable in bearings 12 and 13 provided, respectively, in the body members 2 and 3.

A threaded spindle 14 extends from within the sleeve and through the nut to the exterior of the front end member 3. The spindle is splined to and, therefore, is rotatable by and is displaceable axially relatively to, the sleeve, and makes screw-engagement with the nut; hence, axial displacement of the spindle within the sleeve from a base position forwardly of the body, may be effected rapidly by rotating the nut in the appropriate direction whilst the sleeve is stationary or, at a predetermined slower speed, by continuing the rotation of the nut and rotating the sleeve in the same direction as but at a slower speed than, the nut; subsequently, rapid axial displacement of the spindle within the sleeve rearwards of the body back to the base position, may be effected by continuing to rotate the sleeve and terminating the rotation of the nut.

At least one guide bar 15 which is carried by the front end members 3 parallel to the spindle, is reciprocable axialy within bearing bushes 16 houses within the said body member. The bar also projects forwardly beyond the member 3 and its projecting end carries a gear box 17 provided with at least one forwardly projecting shaft 18 on which a drill bit or any other tool may be carried. The forwardly projecting end of the spindle 14 is journalled in the gear box by bearings 19 and the arrangement is such that any axial displacement of the spindle is transmitted to the guide bar through the gear box.

The gear box may be of the reduction or over-speeding type if the spindle is rotatable by the main motor at a speed not suited to any tool carried on the shaft 18, and/or of the multi-spindle distribution type if more than one tool-carrying shaft is required. Further, one or more additional guide bars may be provided if the size and weight of the gear bov are such that extra support is desirable. If desired, the additional guide bar or bars may be fixed in the front end body member and be received within aligned bearing-bushes in the box.

The guide bar 15 extends into a chamber 20 which is formed in and opens to the exterior of the body between the members 2, 3 and, normally, is closed by a removable cover (not shown). Three switches (see Figs. 3 and 4), namely a normally-closed rear limit switch 21, a normally-closed change-over switch 22, and a normally-open forward limit switch 23, mounted within the chamber and adjustable upon the body longitudinally of the bar, are adapted to be actuated in succession by the bar as and when the latter is reciprocated axially by the spindle, to energise and de-energise contactor switches 24, 25 (see Fig. 5) for respectively opening and closing the alternating current supply circuits of the stator windings of the main and feed motors. When the spindle is in the base position, the rear limit and change-over switches are held open, and the forward limit switch is held closed, by the bar 15.

The main and feed motors are arranged to rotate the sleeve 7 and lead nut, respectively, in the same direction, but the feed motor is arranged to rotate the nut at a greater speed than that at which the sleeve is rotated by the main motor.

The contactor 24 is provided with three normally-open contacts *M1*, *M2*, *M3* which are closed to connect the stator windings of the main motor to a three-phase, mains supply of alternating current when the contactor is energised, with three normally-closed contacts *M4*, *M5*, *M6* which are connected in parallel with and short circuit a corresponding one of three adjustable thyristors or equivalent electronic devices in the mains supply to the feed motor, and are opened when the contactor is energised so that a reduced current of predetermined value is fed to the stator windings of the feed motor, and with a normally-open holding contact *M7* which is also closed when the contactor is energised. The contactor 25 is provided with three normally-open contacts *F1*, *F2*, *F3* which are closed to connect the stator windings of the feed motor to the mains supply when the contactor is energised, with a normally-closed contact *F4* which connects a rectifier 29 to the feed motor and is opened

when the contactor is energised, with a normally-open holding contact *F5* which is closed when the contactor is energised, and with a normally-open safety contact *F6* which is connected in series with the contactor 24 and is also closed when the contactor 25 is energised.

To initiate the operation of the head when, as shown in Fig. 1, the spindle is situated in the base position in which it is at the limit of its rearward travel in the body of the head, a manually-operable master switch 27 (see Fig. 5) is closed so as to energise the contactor 25 whereupon the feed motor F is connected to the mains supply of alternating current through the contacts *M4*, *M5*, *M6*, the lead nut 11 is rotated so that the spindle 14 is fed rapidly forwards to cause the shaft-carried tool or tools to approach a workpiece on which it or they is or are to operate, and the bar 15 travels clear of and allows the rear limit switch to close. As the tool or tools is or are about to contact the workpiecc, the bar 15 travels clear of and allows the change-over switch 22 to close so as to energise the contactor 24 and connect the main motor to the mains supply, and the feed motor to the said supply through the thyristors 26; consequently, the spindle is rotated by the main motor, the current supplied to the feed motor is reduced to a predetermined value which may be varied by adjusting the thyristors, but, nevertheless, is always sufficient to enable the feed motor to rotate the nut at a greater speed than that of the spindle; since both the nut and the spindle are rotated, the rate of forwards travel of the spindle is reduced whilst the tool, or tools, performs or perform, its or their intended operation or operations on the workpiece under power derived from both of the motors. When the said operation or operations is or are completed, the bar 15 travels clear of and allows the forward limit switch 23 to open so as to de-energise the contactor 25, and disconnect the feed motor from the supply, whereupon a direct current is fed to the stator windings of the said motor through the rectifier 29 (see Fig. 6) with the result that the rotation of the rotor 10 and lead nut is terminated instantaneously, and the rotating spindle is fed rapidly rearwards in the body to retract the tool or tools from the workpiece, until, when the spindle again reaches the base position, the bar opens the rear limit switch 21 so as to de-energise the contactor 24, disconnect the main motor from the mains supply, and terminate the rotation of the spindle.

To enable the head to be set up for performing the same cycle of operations in succession on each of a quantity of identical workpieces, a manually-operable inching switch 30 is provided in the intermediate body member 2. Normally, the switch 30 is isolated by a manually-operable change-over switch 31 (see Fig. 5) which, upon being actuated to its alternative position, isolates the master switch 27 and connects the inching switch to the contactors 24, 25. The inching switch is adapted to be actuated to either of two alternative circuit-closing positions in which, respectively, it energises the contactor 25 and the contactor 24. Hence, by repeatedly actuating the inching switch to and from the position wherein it energises the contactor 25, the feed motor is caused to rotate the lead nut, step-by-step, until, first, the shaft-carried tool or tools is or are about to contact one of the workpieces, whereupon the bar-actuated change-over switch 22 is adjusted upon the body of the head and lengthwise of the bar to a position wherein it is operable by the bar, and secondly, until the operations on the workpiece have ben completed, whereupon the forward limit switch 23 is likewise adjusted to a position wherein it is operable by the bar. Subsequently, the inching switch is actuated repeatedly to and from the position wherein it energises the contactor 24 until the tool or tools is or are retracted from the workpiece, whereupon the rear limit switch 21 is adjusted to its bar-operable position.

The machining head shown in Figure 2 differs from that shown in Figure 1 mainly in that, the main and feed motors *M* and *F*, instead of being arranged in co-axial alignment, are arranged side-by-side and drive from the rotor 10 of the feed motor to the lead nut 11 is effected by an endless toothed belt 32 which engages pinions 33, 34 fast upon a rotor shaft 35 and the nut respectively.

In addition, the head is provided with a clutch comprising a driving member 36 which is fast upon the spindle 14 and a driven member 37 which is fast upon the lead nut and is adapted to be engaged by the said driving member when the spindle is returned to the base position provided that, previously, the location of the reverse limit switch 21 has been adjusted so that it is not opened by the bar 15. Hence, at the end of each cycle of operations of the head, the spindle continues to rotate and rotates the nut at the same speed and the nut rotates the rotor 10; however, although the spindle is rotating, it is not displaced axially but initiation of the next operational cycle is expedited upon actuation of the master switch which, in this case, as it connects the feed motor to the alternating current supply, disconnects the main motor from the said supply.

If desired, for example by providing the spindle and lead nut with threads of the opposite hand to that assumed in the foregoing, the order in which the two motors are started and stopped may be reversed; in such circumstances the thyristors 26 and the rectifier 29 will be connected in the mains supply circuit

to the main motor. Also, if desired and irrespectively of the order in which the two motors are started and stopped, the thyristors 26 may be connected in the mains supply circuits of both motors. Further, the head shown in Figure 1 may also be provided with a clutch such as the clutch 36, 37 shown in Figure 2.

WHAT I CLAIM IS:—

1. A self-contained machining head of the kind referred to, comprising two electric motors, of which at least one surrounds and is co-axial to the spindle, for respectively driving the spindle and lead nut, a master switch for connecting a first one of the motors to a supply of current to initiate an operational cycle of the head, a change over switch operable in response to a change in the axial position of the spindle as the spindle is advanced towards a workpiece, for connecting the second one of the motors to the current supply and at least one of the motors to the supply through manually adjustable thyristors or equivalent electronic devices, and a forward limit switch operable in response to a change in the axial position of the spindle as the tooling operates on the workpiece, for disconnecting the said first motor and the electronic devices from the supply.

2. A self-contained machining head as claimed in claim 1, which also comprises a rear limit switch which is operable in response to a change in the axial position of the spindle as the tooling is retracted from the workpiece, for disconnecting the second motor from the supply, and a clutch of which the co-operating drive-transmitting members are, respectively, fast upon the spindle and lead nut and are engageable to enable the spindle and nut to be rotated at the same speed, also as the tooling is retracted from the workpiece, the location of the rear limit switch axially of the spindle being adjustable so that, as desired, either the switch may be operated or the clutch may be engaged as the tooling is retracted, and the master switch being adapted to disconnect the second motor from the supply when actuated to connect the first motor to the supply if such disconnection has not been effected previously by the rear limit switch.

3. A self-contained machining head as claimed in claim 1 or claim 2 wherein the motors are of the alternating current type and the forward limit switch is adapted, when operated to disconnect the first motor from a supply of alternating current, to effect the connection of the motor to a supply of direct current so that rotation of the motor rotor is terminated instantaneously.

4. A self-contained machining head as claimed in any of the preceding claims wherein both of the motors surround and are co-axial to the spindle.

5. A self-contained machining head as claimed in any of claims 1—3 wherein only one of the motor surrounds and is co-axial to the spindle and a drive-transmitting mechanism is provided between the other motor and the lead nut or the spindle.

6. A self-contained machining head substantially as herein described with reference to Figures 1 and 4—6 or Figures 2—6 of the accompanying drawings.

ARTHUR SADLER & SON,
Chartered Patent Agents,
Agents for the Applicants,
49—50, Calthorpe Road,
Edgbaston,
Birmingham, B15 1TR.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1972.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1266132 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

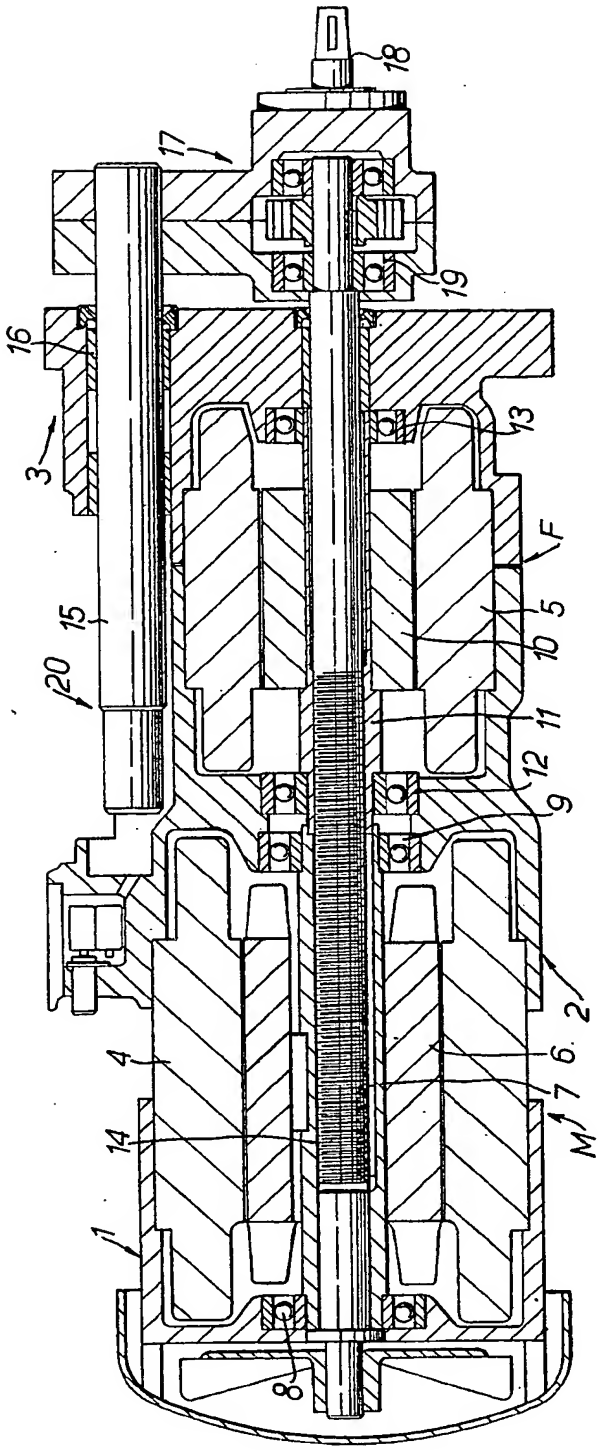

Fig. 1.

1266132 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

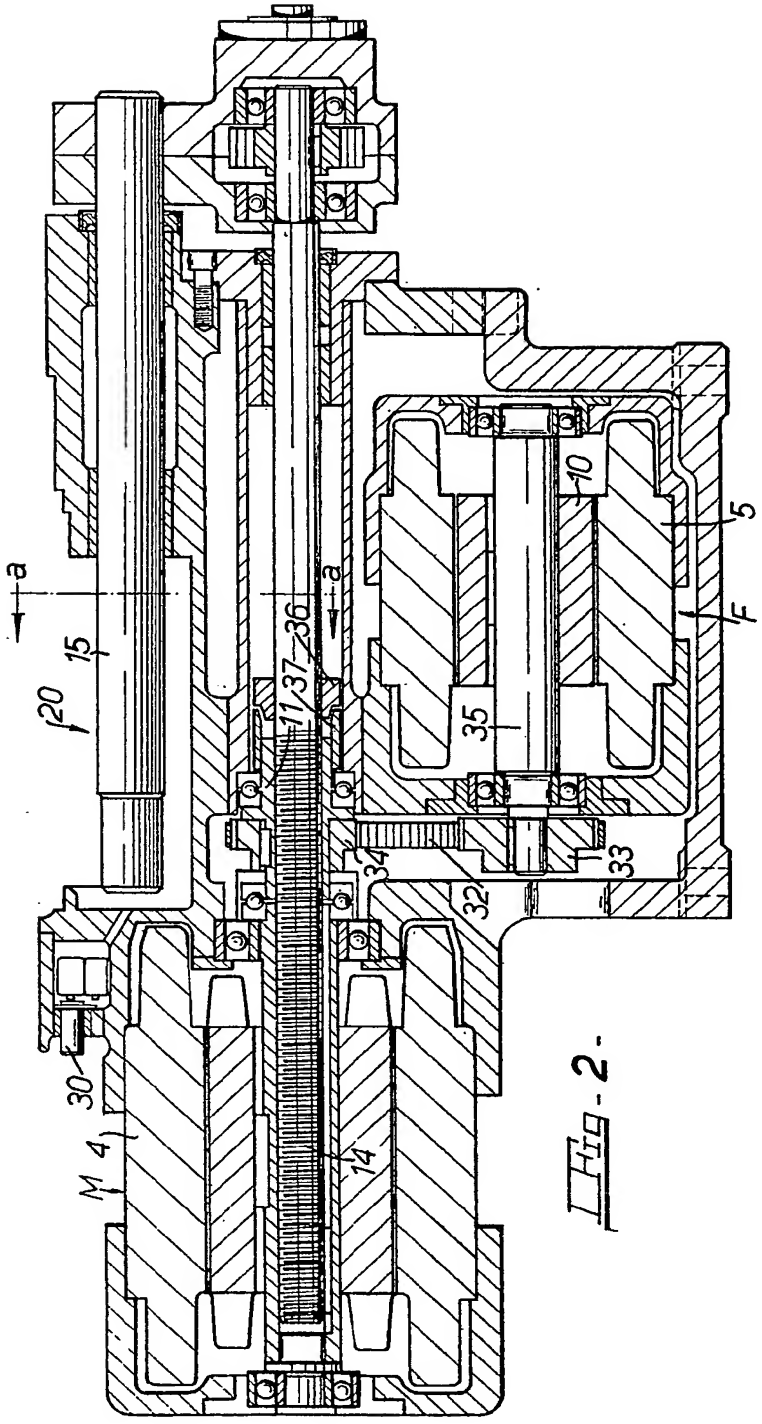

Fig. 2.

1266132 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

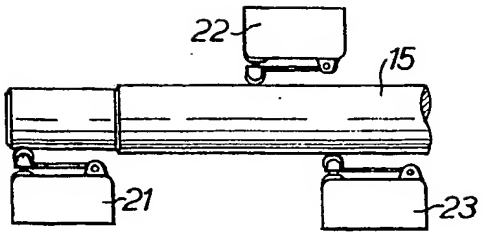

FIG - 4 -

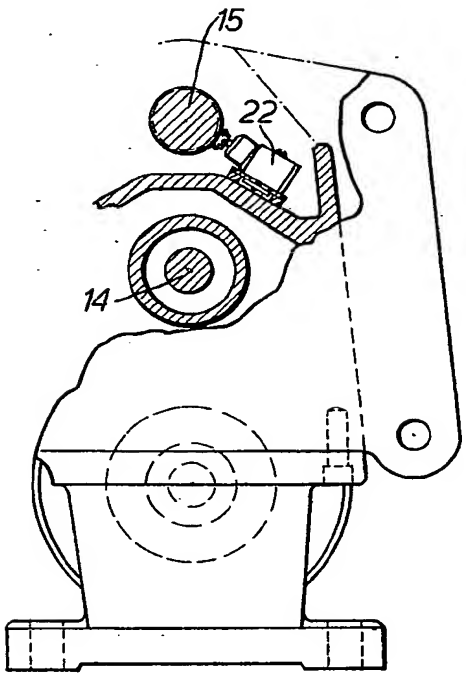

FIG - 3 -

1266132 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 4

Fig - 5 -

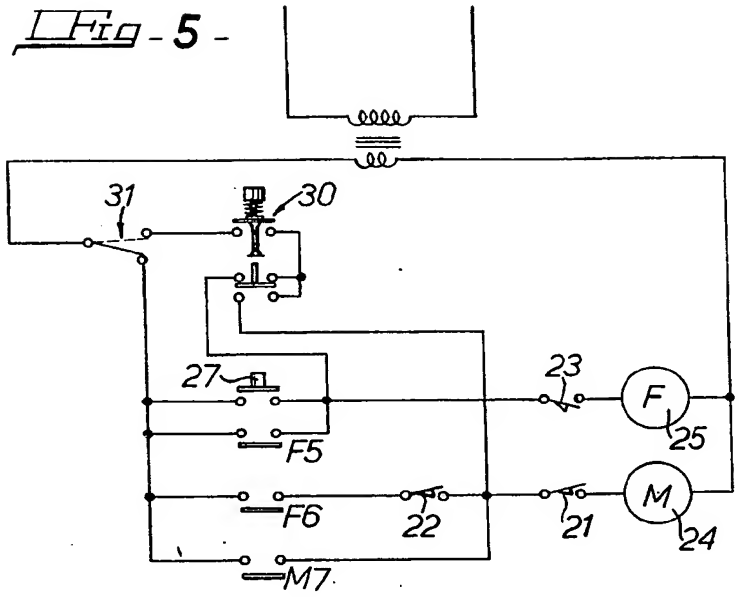

Fig - 6 -